Introduction to Cartography Part II

Cartographers get embarrassed about big empty spaces.

Terry Pratchett

Introduction to Cartography

- Map Projections
- GIS
- GPS
- Remote Sensing
- Misrepresentation with Maps

Map Projections

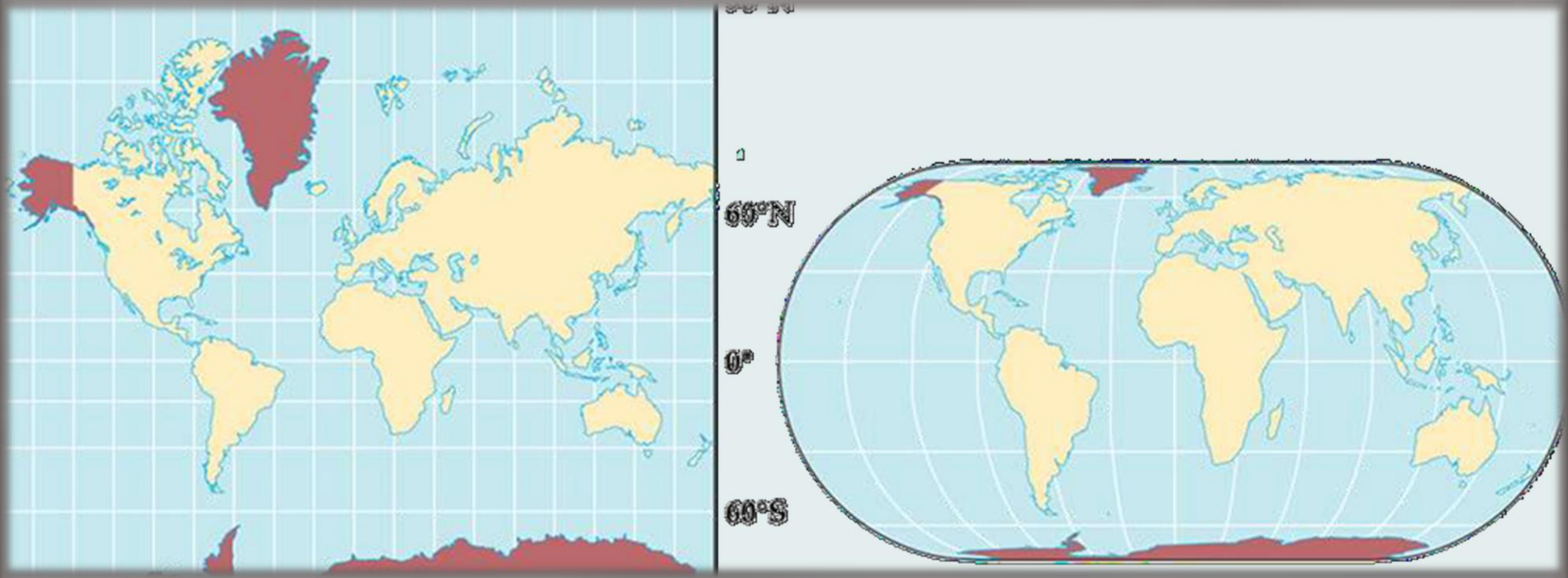
- Mathematical method for systematically transforming a 3-D earth into a 2-D map.
- Three traditional types:
  - cylindrical
  - conical
  - azimuthal / planar / zenithal
- Newer Mathematical Projections

Cartographer's Dilemma

- Because maps are 2-D renderings of 3-D images, all maps introduce distortion:
  - shape (conformance)
  - size (equivalence)
  - direction
  - distance
- Maps can be either equivalent or conformal, but cannot be both.

Conformality vs. Equivalence

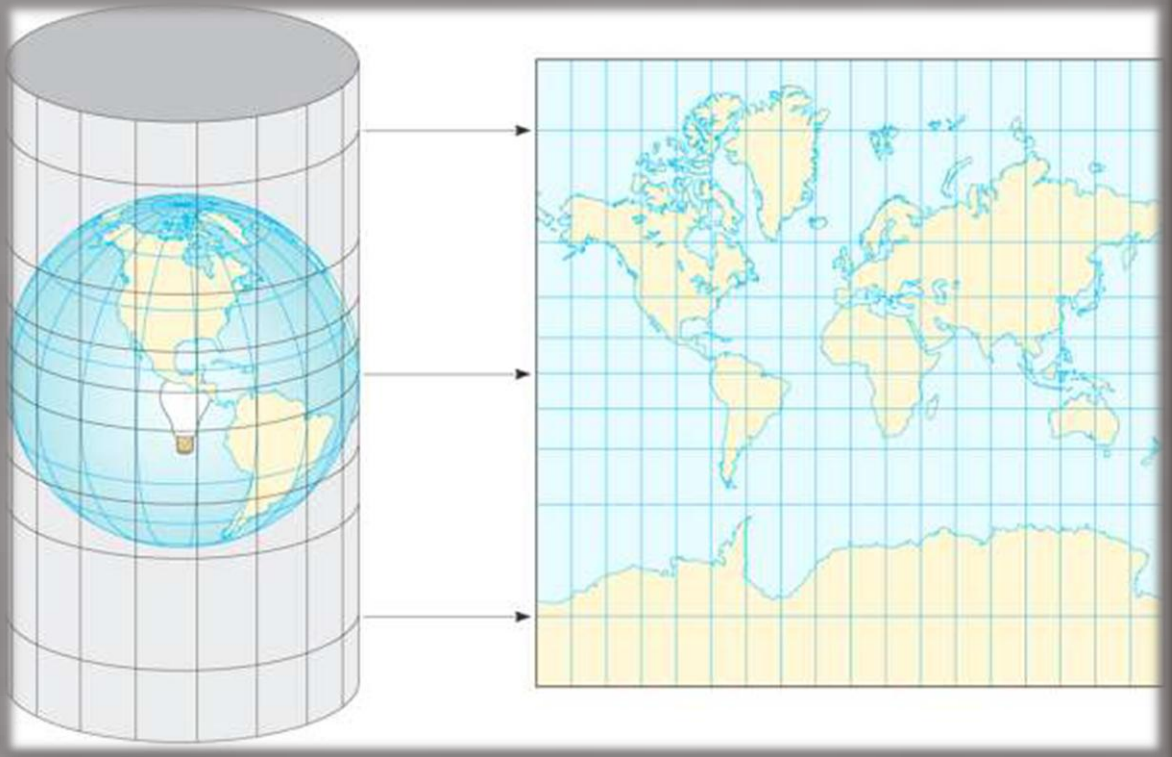
This map preserves the correct shapes of things (conformality), but sacrifices their correct sizes vis-à-vis each other.



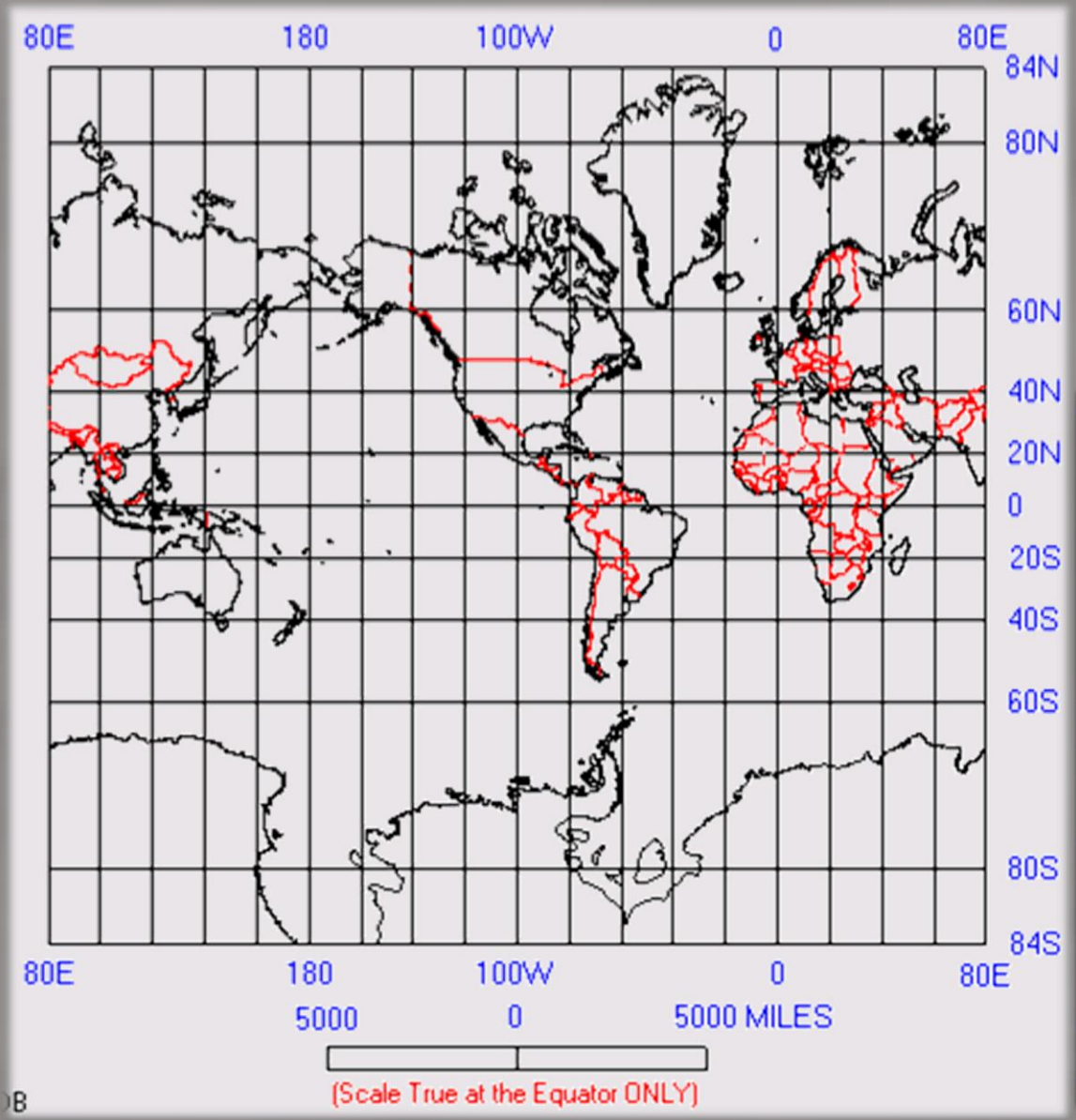
This map preserves the correct sizes of things vis-à-vis each other (equivalence), but sacrifices their correct shapes.

Cylindrical Projections

- created by mathematically "wrapping" a globe in a cylinder in order to produce a rectangular surface possessing a grid of lines of latitude and longitude
- examples – Mercator, Miller, Plate Carrée
- emphasize conformality, distort equivalence



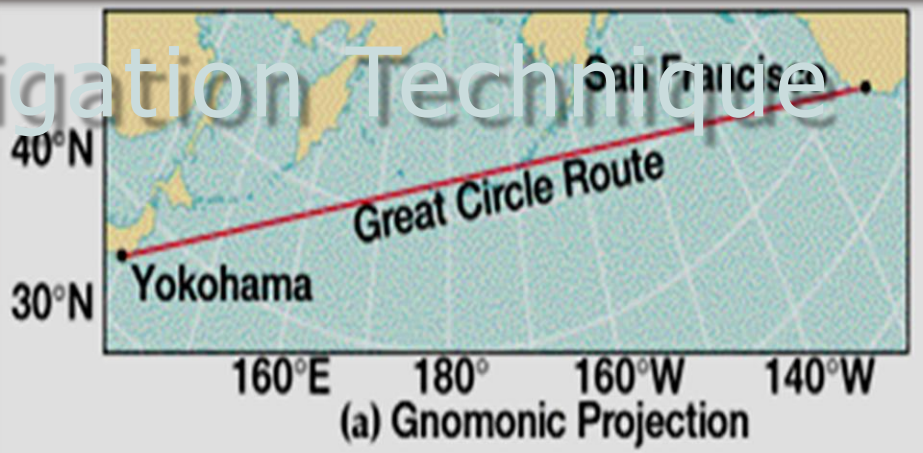
The Mercator Chart, 1569



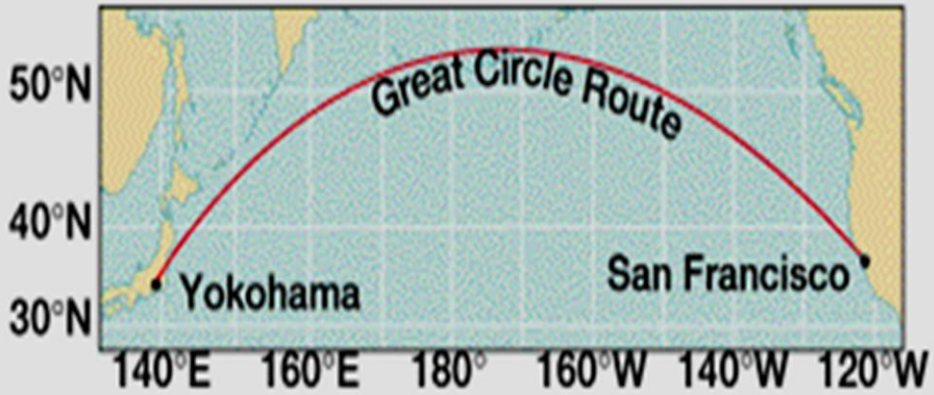
Note the incorrect sizes.

Mercator's Navigation Technique

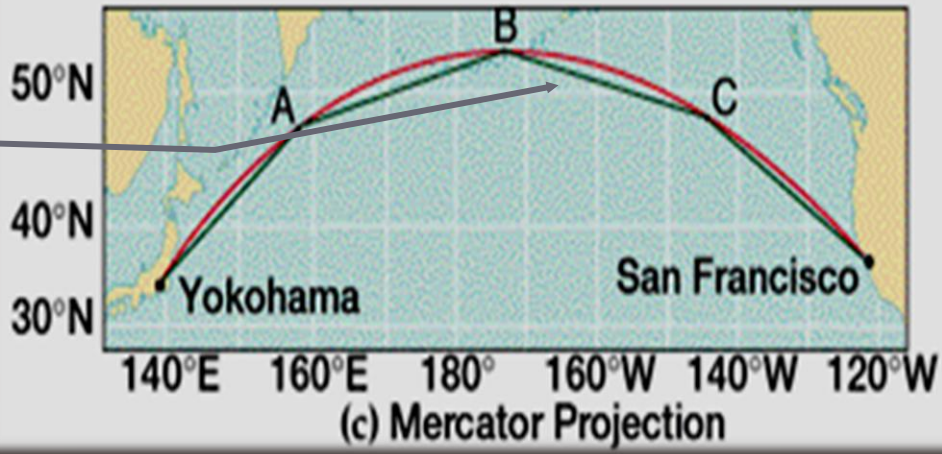
- Gnomonic Projection (at top) shows great circle as straight line.
- Mercator Projection shows constant compass headings (azimuth) as straight lines.



(a) Gnomonic Projection



(b) Mercator Projection



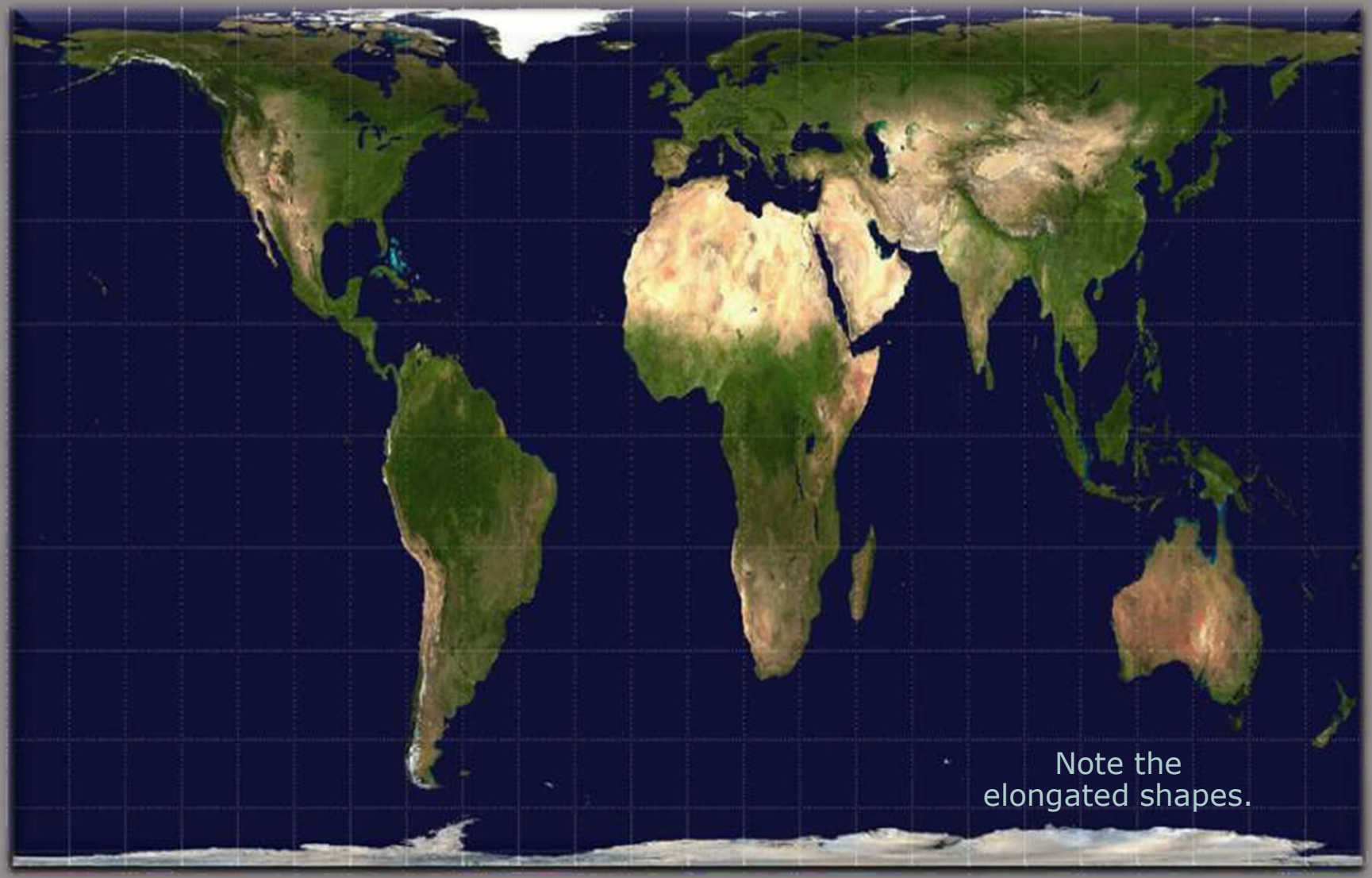
(c) Mercator Projection

Rhumb Lines

In navigation, a Rhumb line is an arc crossing all meridians of longitude at the same angle, a path with constant bearing as measured relative to true or magnetic north.

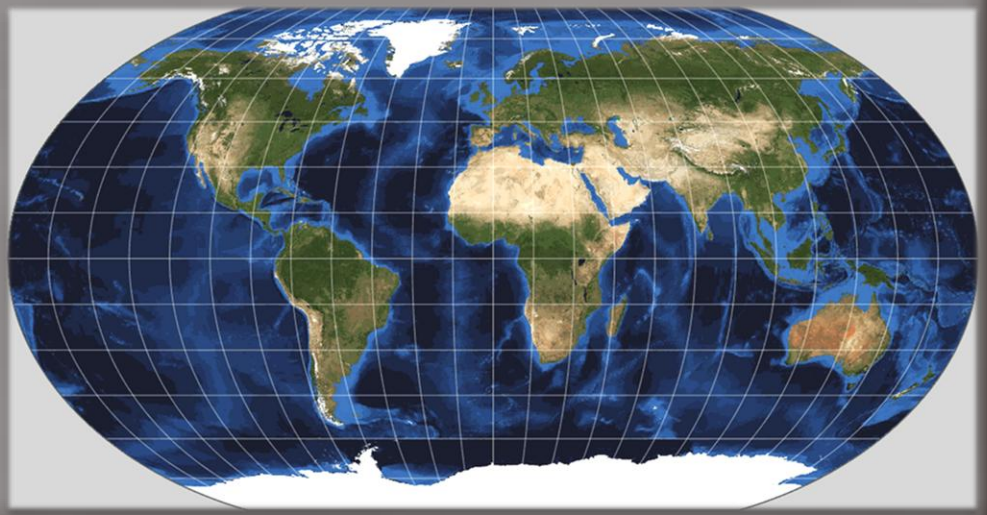
Gall-Peters Projection

Equivalent (Equal Area) Map Projection



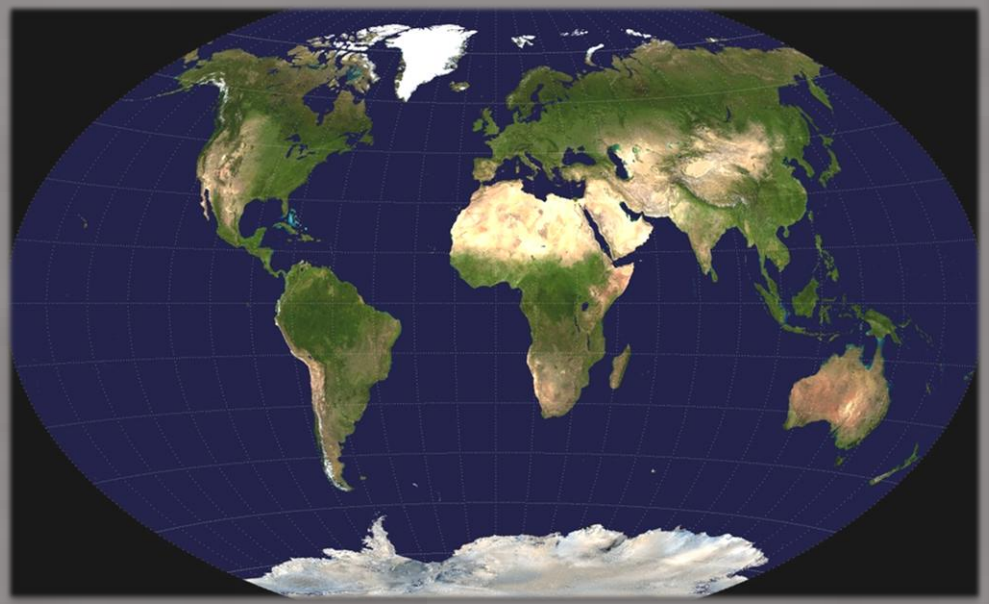
Robinson Projection

- cylindrical projection
- neither equivalent or conformal, preserves nothing but looks good
- a compromise that attempts to preserve enough area, shape, distance and direction so that the earth "looks right"
- used by National Geographic at one time to create their world maps



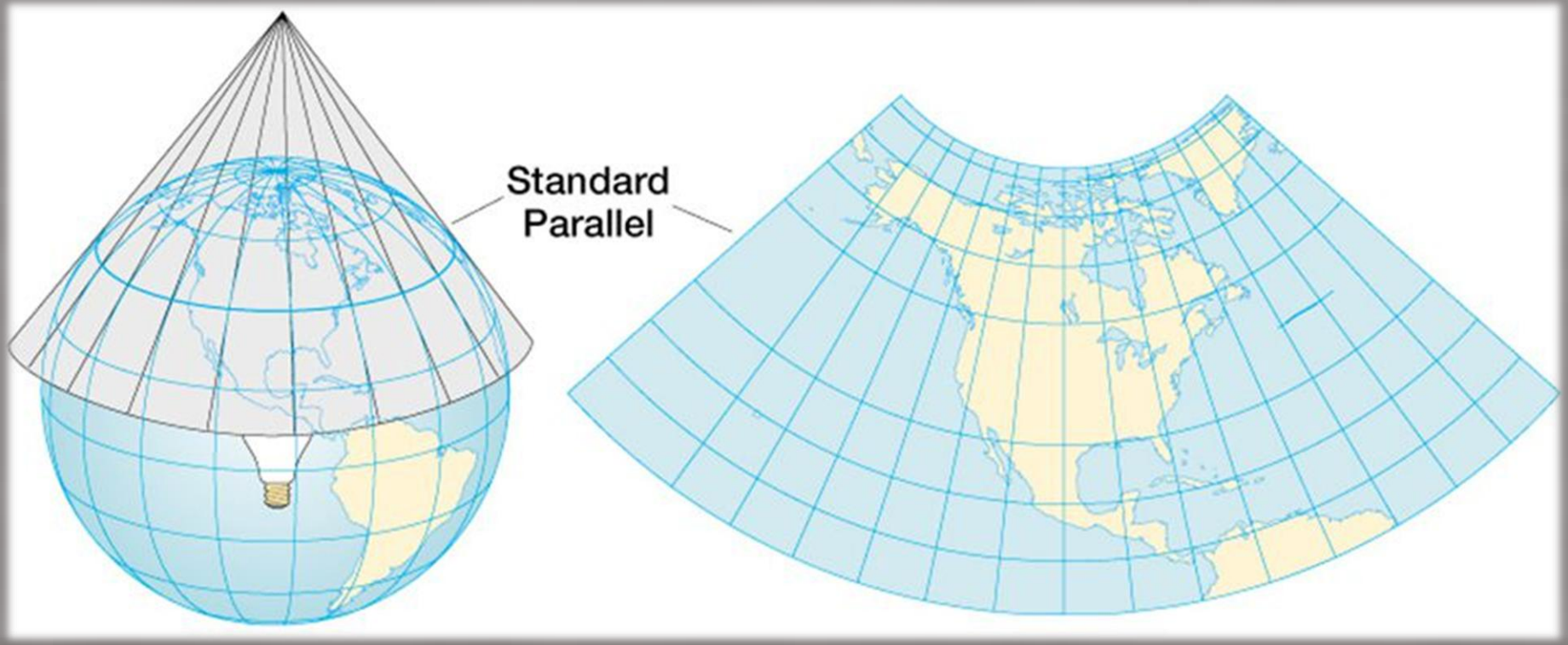
Winkel Tripel Projection

- a type of pseudocylindrical projection map in which both the lines of latitude and longitude are curved
- adopted by the *National Geographic Society* in the late 1990s (replacing the Robinson projection)

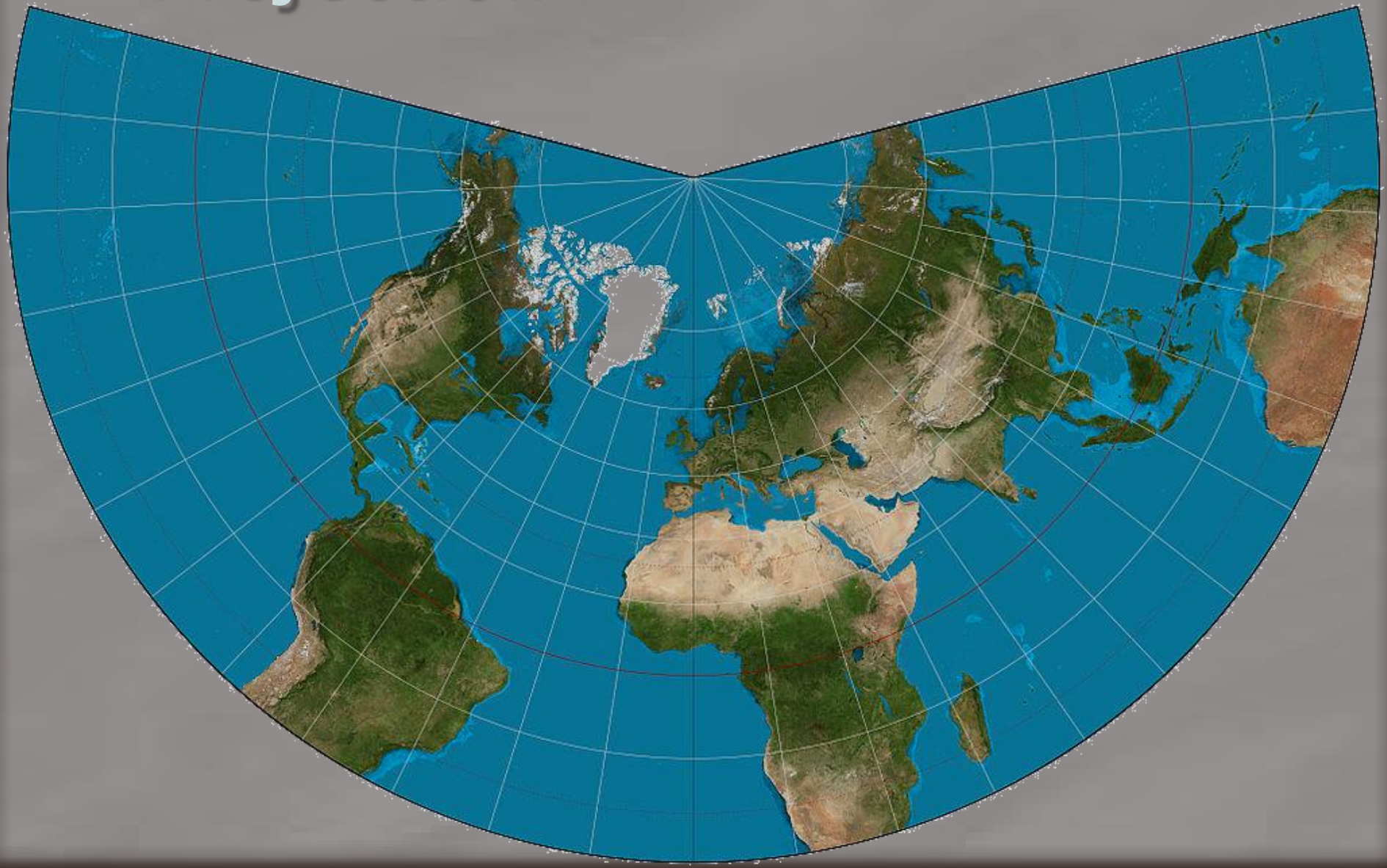


Conic Projections

- created by projecting the markings of a center-lit globe onto a cone intersecting a portion of the globe
- examples – Lambert, Albers Equal-Area, Murdoch
- emphasize equivalence, distort conformality

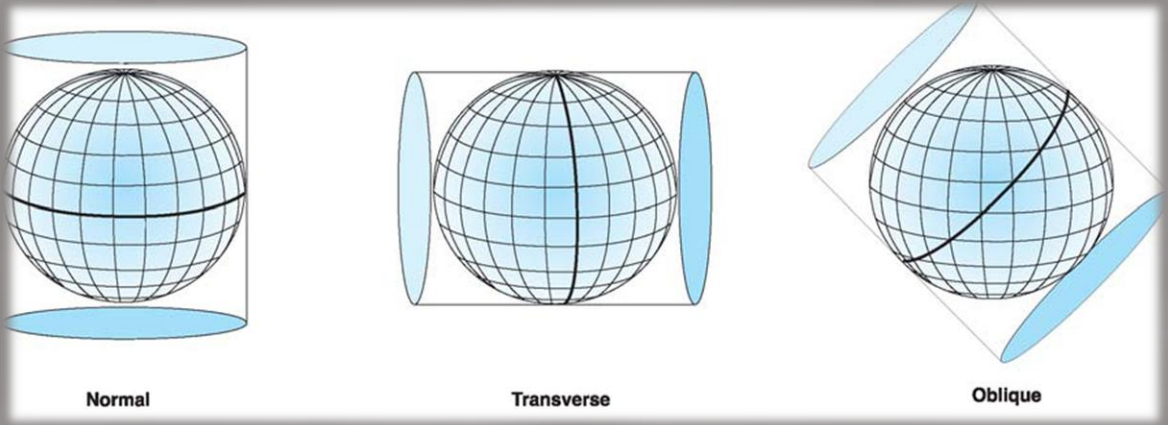


Lambert Conformal Conic Projection

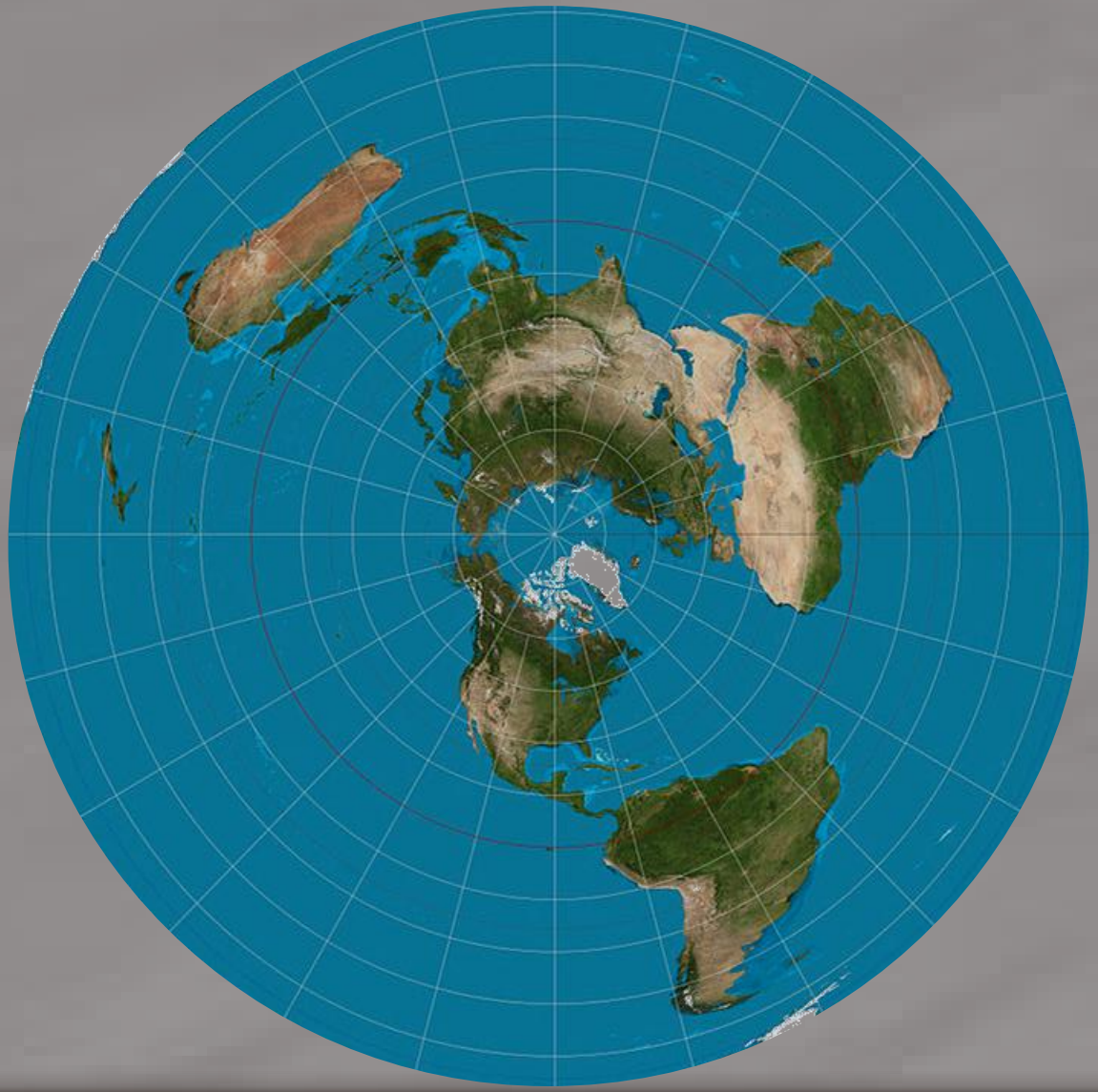


Azimuthal Projections

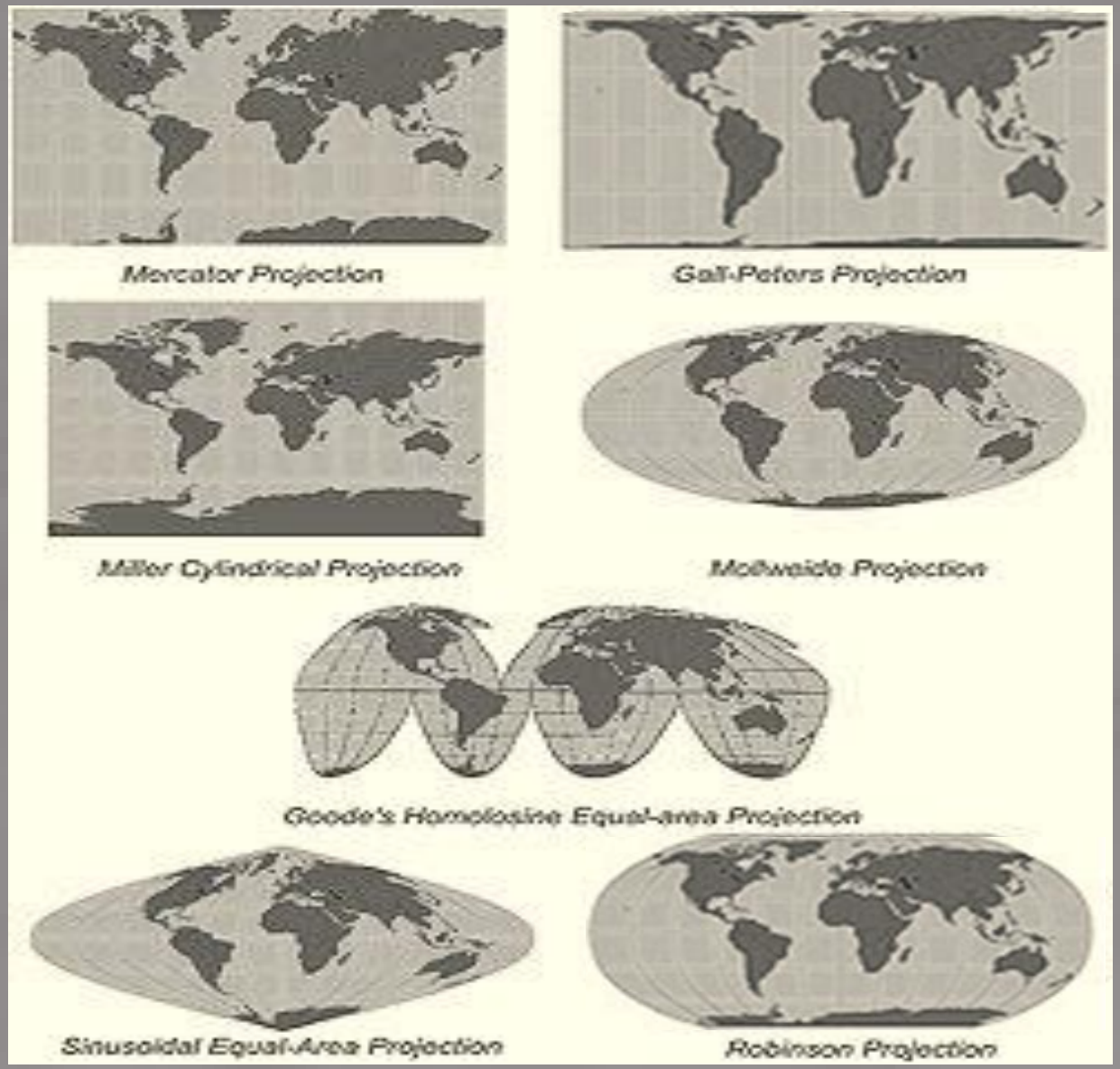
- created by projecting the markings of a center-lit globe onto a flat piece of paper
- examples – Aitoff, Briesemeister, Hammer
- depending on the method used, can emphasize either conformality or equivalence but not both at the same time



Azimuthal Equidistant Projection



Map Projection Distortions



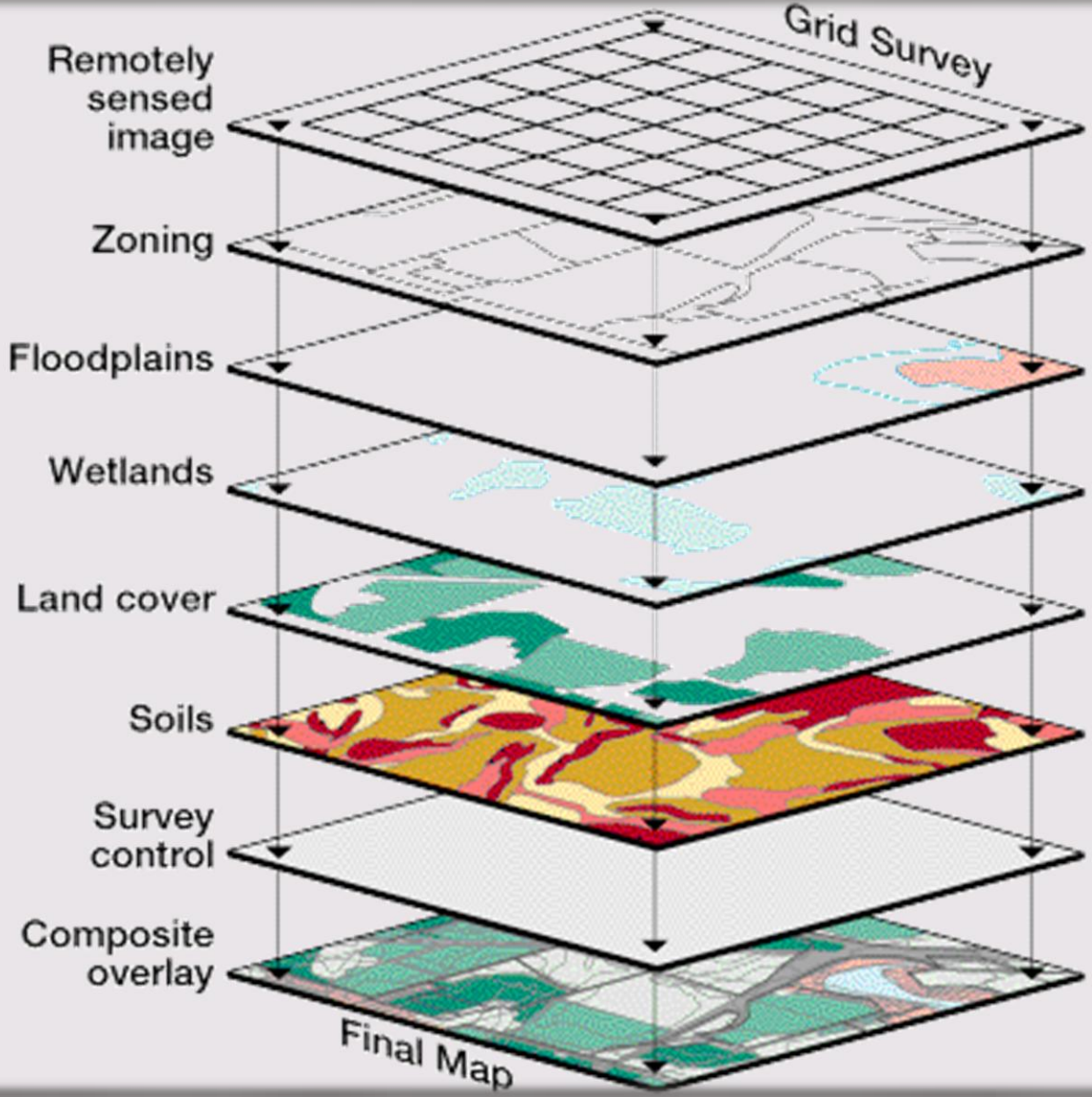
What is GIS?

- stands for geographic information systems
- a system for the input, storage, manipulation and output of geographic data
  - a specialized information system used to work with (manipulate, summarize, query, edit, visualize) information stored in computer databases
  - utilizes spatial indexing of information to track *what is where* on the Earth's surface

Elements of a Geographic Information System (GIS)

- database with spatially-coded data (latitude/longitude)
- computer
- GIS application software (ArcView, ArcInfo, MapInfo)
- video map display
- scanners
- digitizer
- plotter/printer

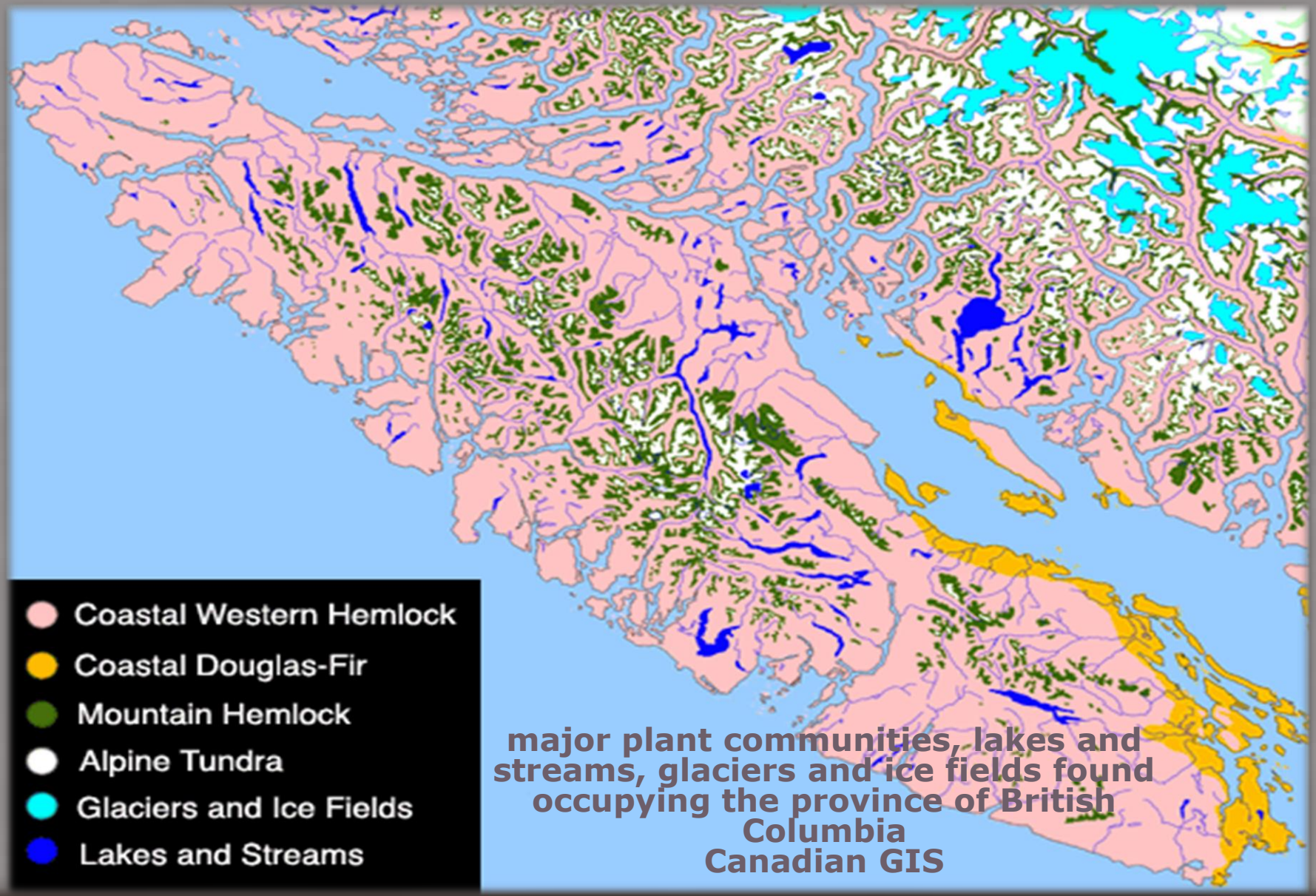
A GIS Project



Functions of a Geographic Information System

- site selection
- find density within an area
- catalogue and track spatial data
  - land use maps, for example
- network functions
  - street grid navigation
  - municipal water supplies, sewers
  - hydrology (rivers, streams, lakes)
- consumer tracking and marketing

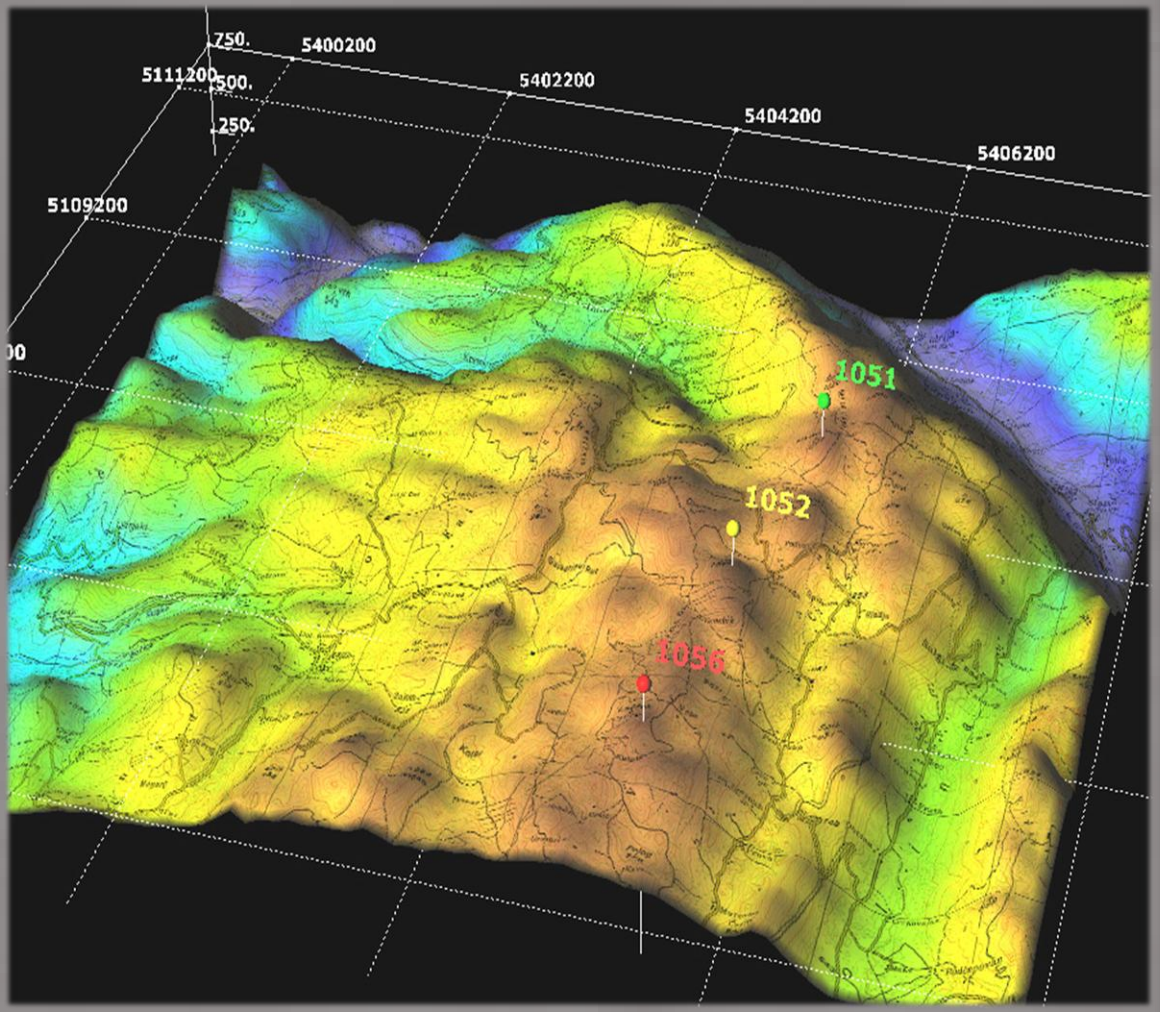
Natural Resource GIS



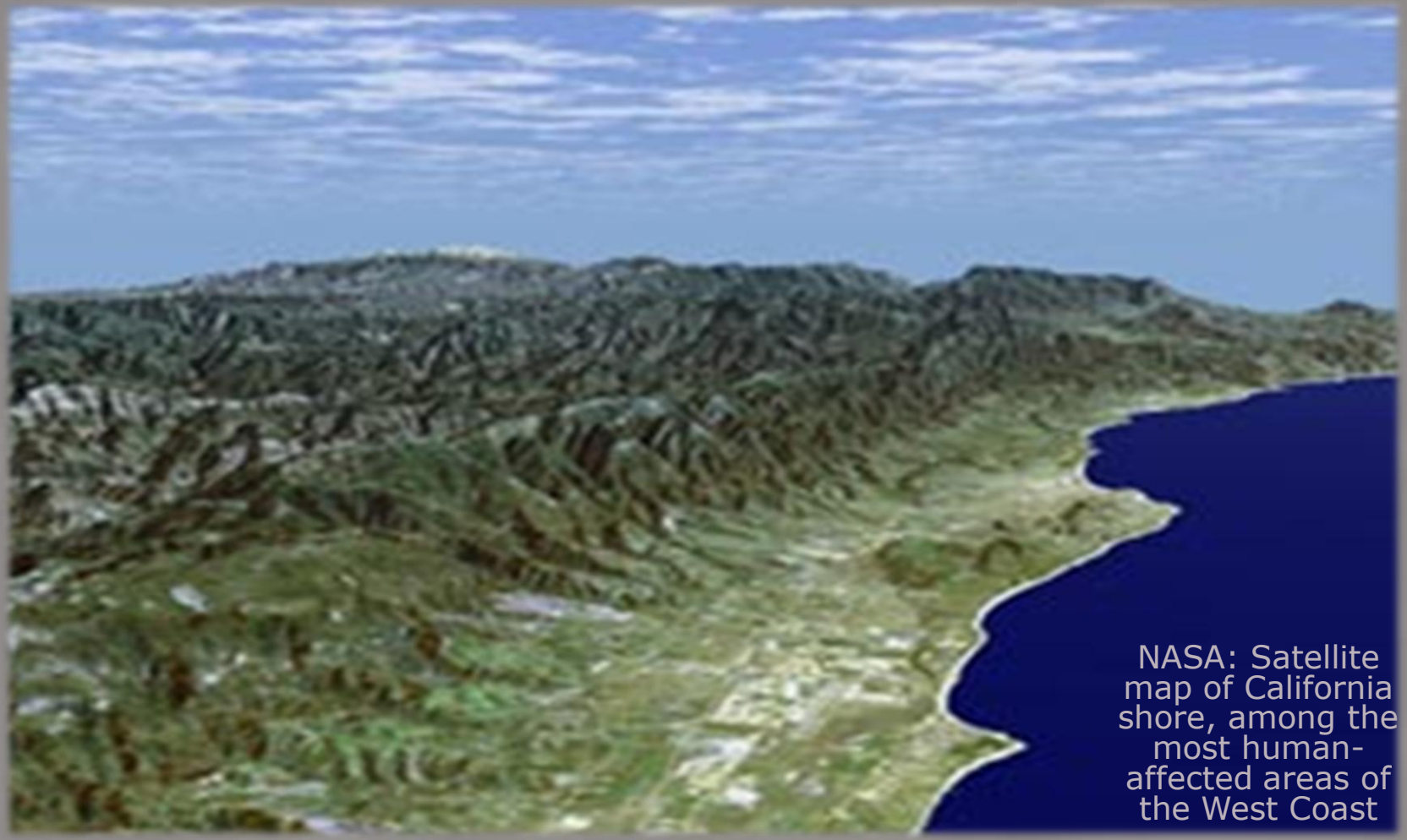
major plant communities, lakes and streams, glaciers and ice fields found occupying the province of British Columbia
Canadian GIS

GIS Spatial Linking

GIS works by storing information as a collection of thematic layers that can be linked together by geography. This simple but extremely powerful and versatile concept has proven invaluable for solving many real-world problems from modeling global atmospheric circulation to predicting rural land use and monitoring changes in rainforest ecosystems.



High GIS Quality Map Display



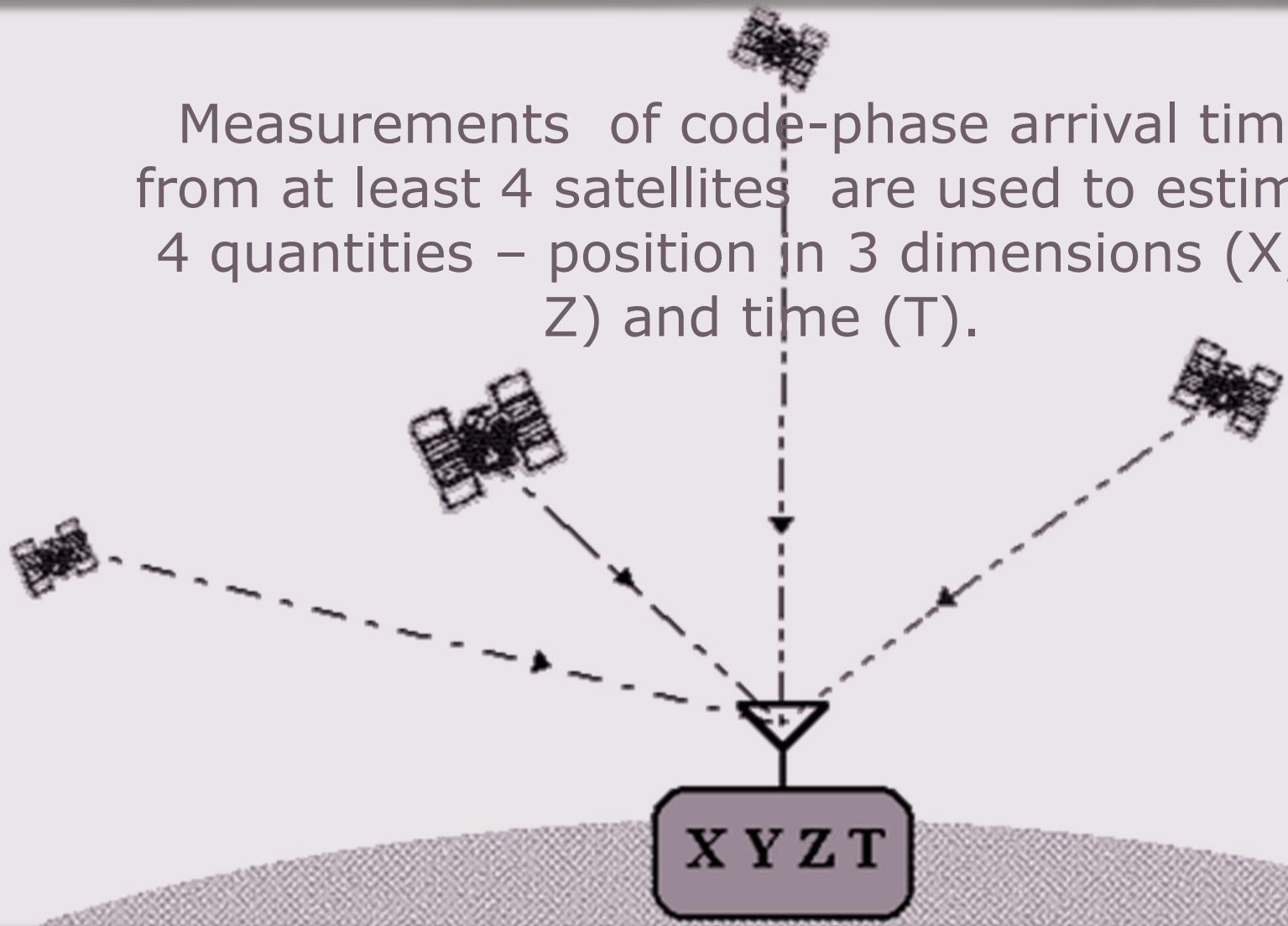
NASA: Satellite map of California shore, among the most human-affected areas of the West Coast

Links to Geographic Information Systems Sites

- Google Maps
- Google Earth
- Zillow.com
- National Atlas of the United States

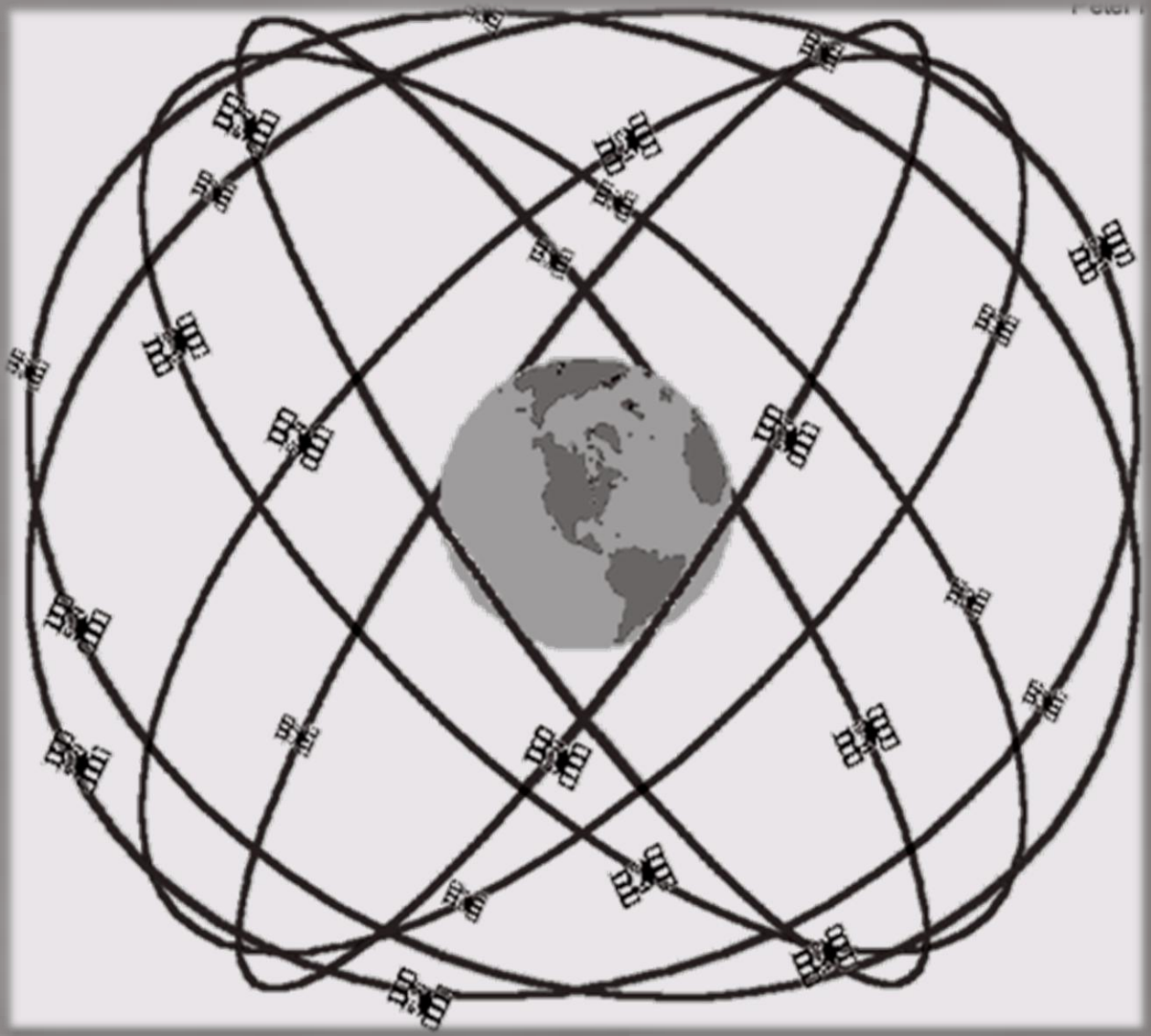
Global Positioning System (GPS)

Measurements of code-phase arrival times from at least 4 satellites are used to estimate 4 quantities – position in 3 dimensions (X, Y, Z) and time (T).

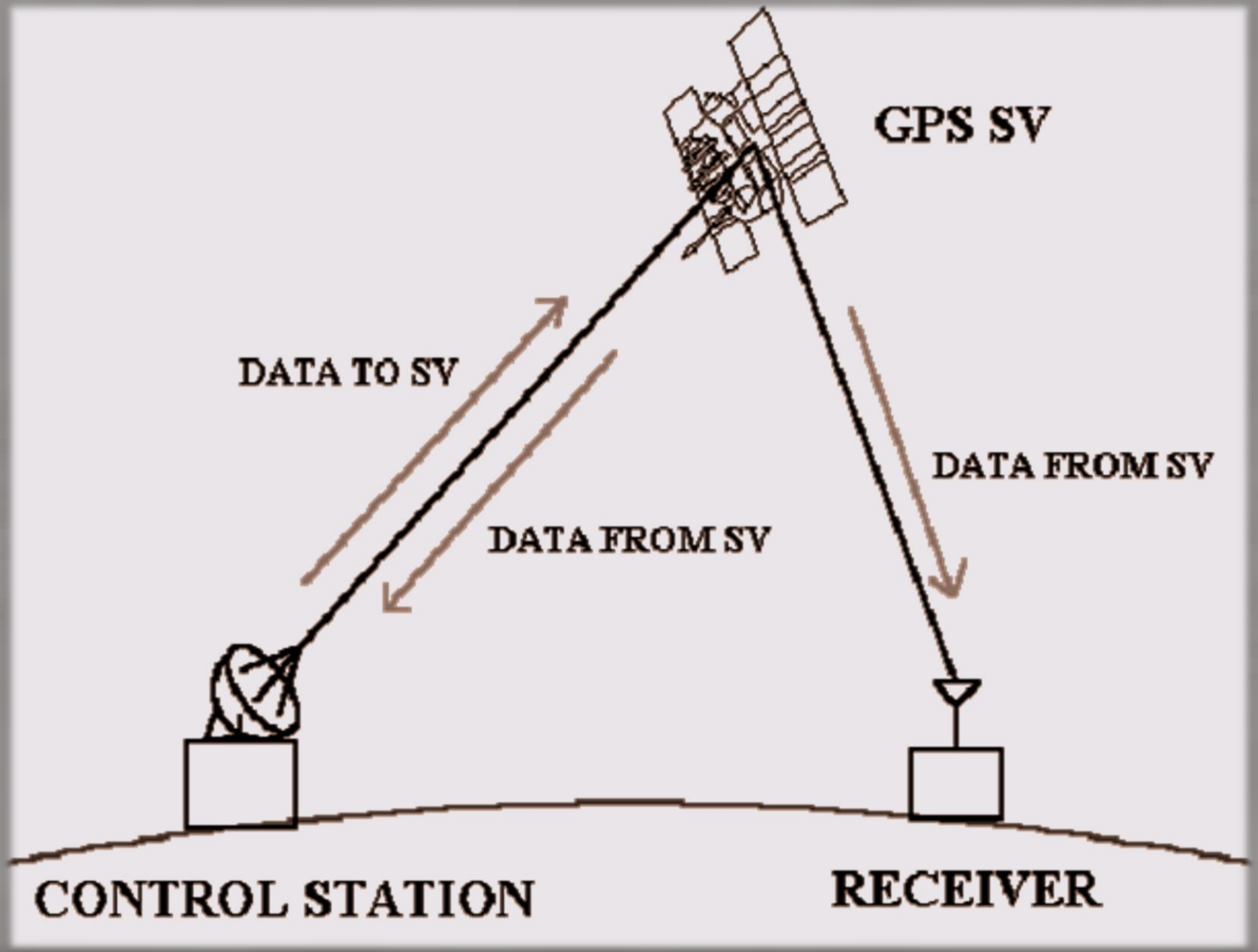


GPS Nominal Constellation

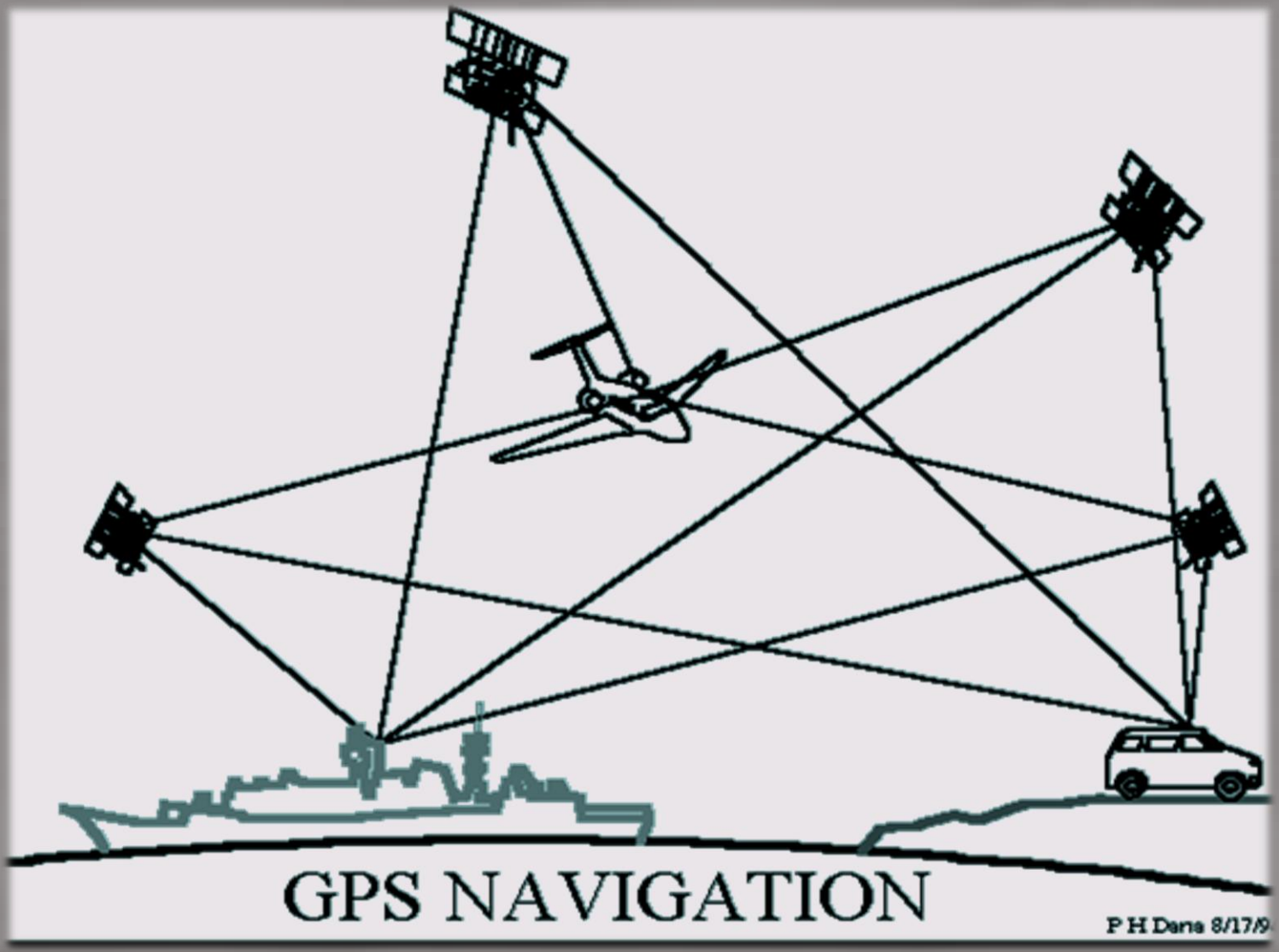
- 24 satellites in 6 orbital planes
- 4 satellites in each plane
- 20,200 km altitudes, 55° inclinations



GPS Control


GPS SV
DATA TO SV
DATA FROM SV
DATA FROM SV
CONTROL STATION
RECEIVER

GPS and GIS are increasingly integrated.



Photographic Remote Sensing

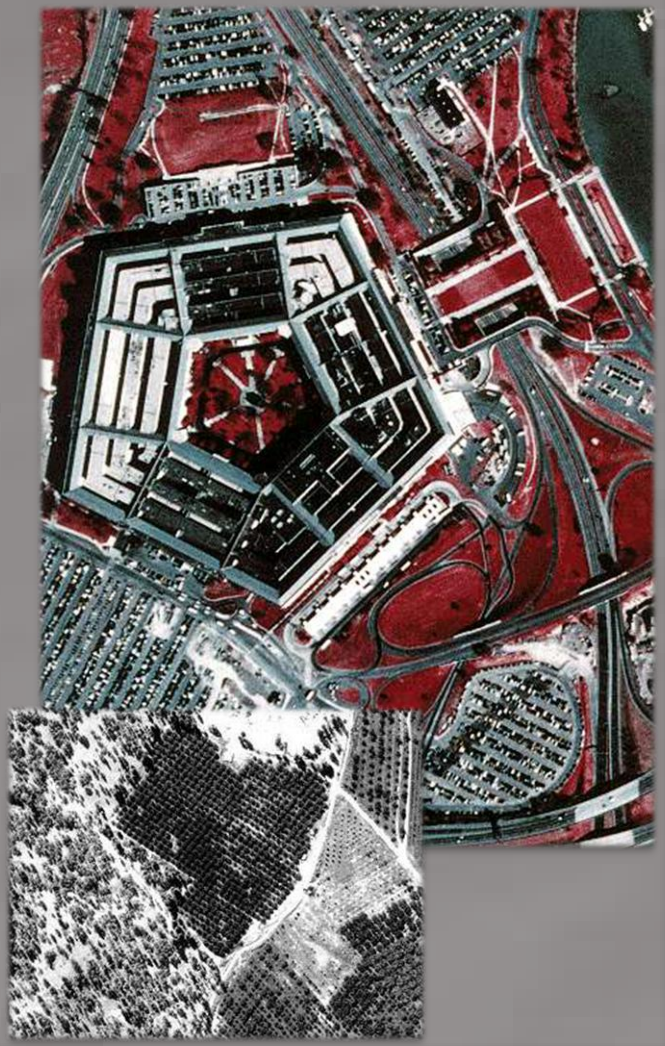
- aerial photos camera mounted on airplane takes visible light photographs
- infrared film sensitive to red end of the light spectrum (crops and plants)

Digital Remote Sensing

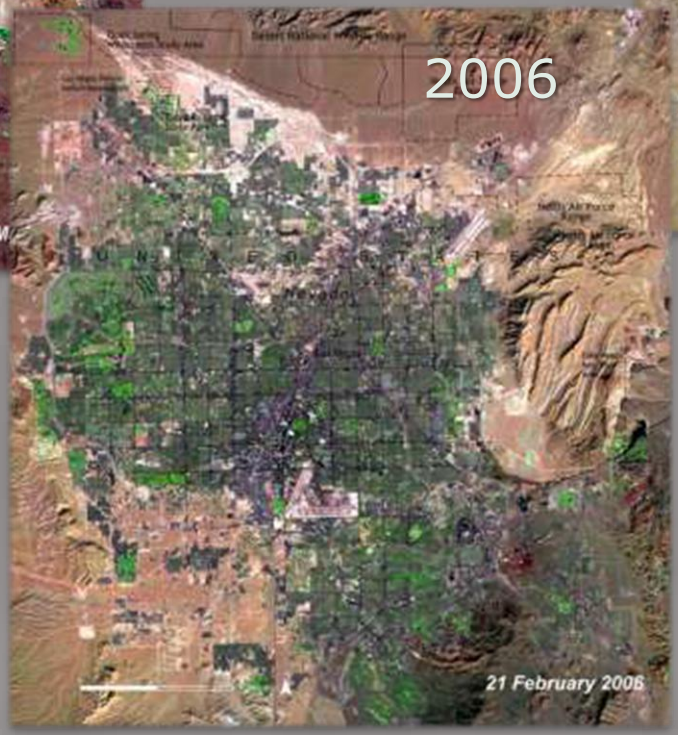
- multispectral sensors
  - visible, radar, infrared, ultraviolet
- digital image manipulation
- direct download into GIS systems

Interpreting Aerial Photos and Remotely-Sensed Images

- Image tone / color / reflectivity – Colors and reflected UV and infrared give clues to landscape elements. For example, infrared film or sensors return shades of pink and red for healthy vegetation.
- Texture – The coarseness or smoothness of a surface can help in identification.
- Pattern – Human systems and some physical systems have clear patterns.
- Shadows – Provide clues to the height and size of objects.

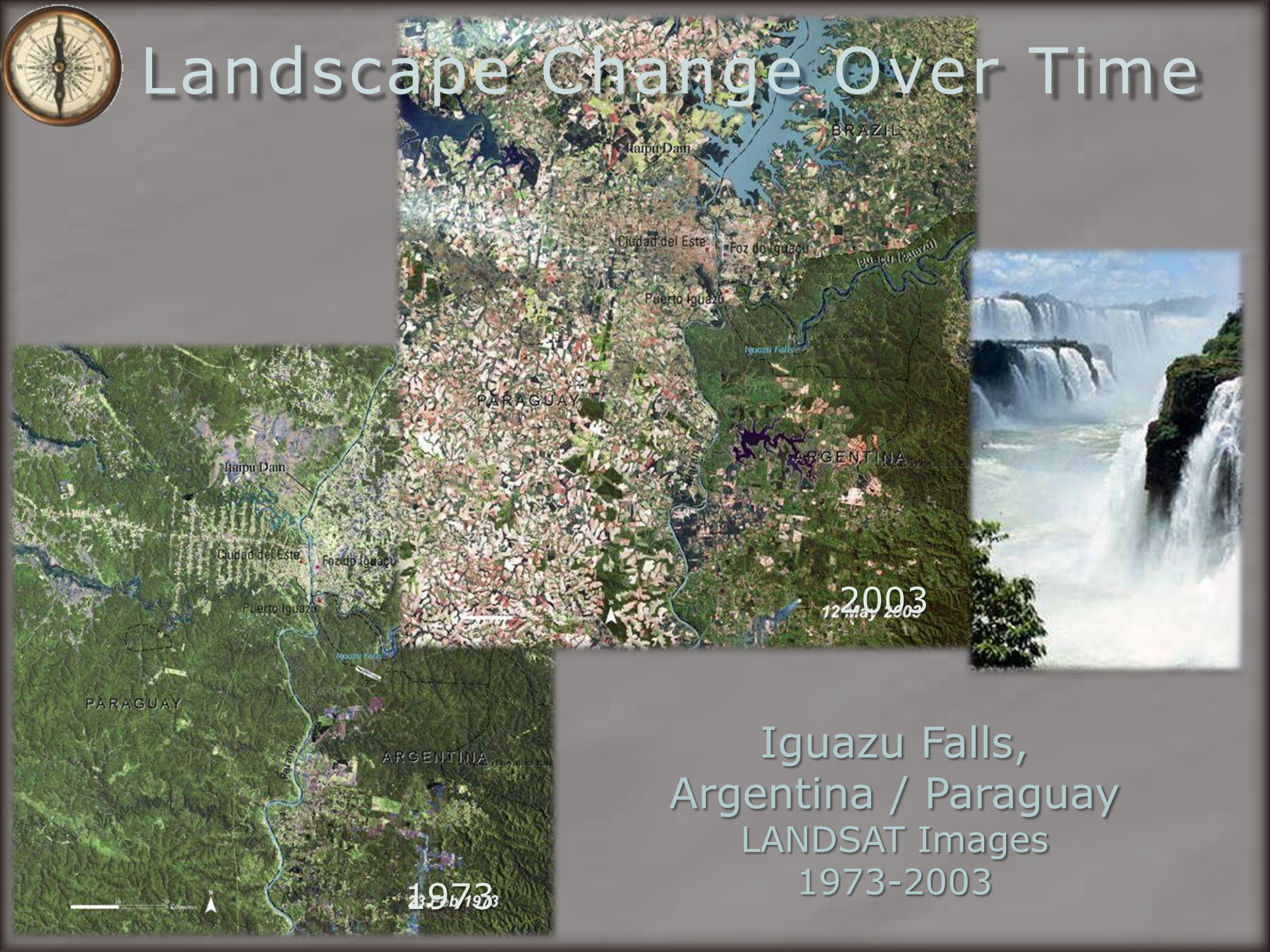


Landscape Change Over Time



Las Vegas Nevada
LANDSAT Images
1973-2006

Landscape Change Over Time



Iguazu Falls, Argentina / Paraguay

LANDSAT Images

1973-2003

Misrepresentation with Maps

- Misrepresentation: Maps are often perceived as more or less agnostic, but they can be instruments of propaganda just as much as any graphic image.
  - propaganda maps
  - selection or omission of map features
  - scale
  - orientation
  - links
  - the power of maps

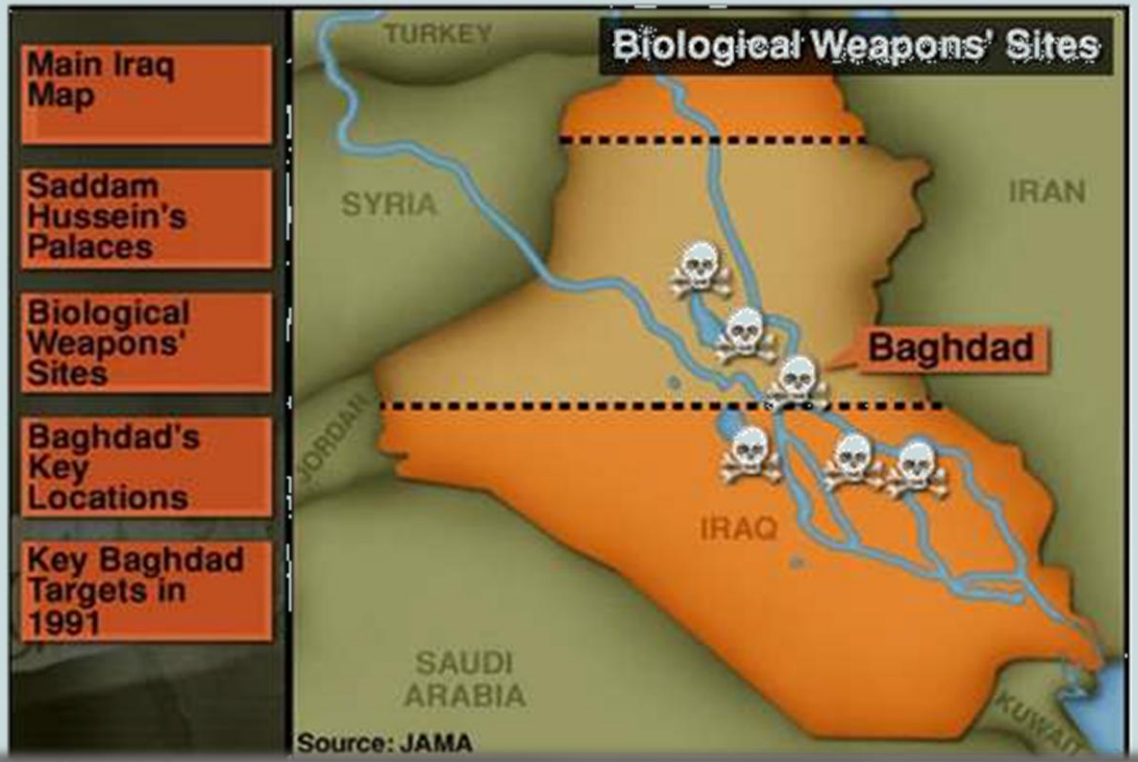
Misrepresentation with Propaganda

1905 Japanese Map from before the Russo-Japanese War

Misrepresentation with Propaganda

Iraq: What's where

From the targets in the 1991 Persian Gulf war to the locations of Saddam Hussein's palaces, our interactive map gives you a visual break-down of what's where in Iraq. Roll over or click on the orange buttons on the left for the relevant information.



Map from CNN.com on 02/02/2003, one month before the invasion of Iraq.

Misrepresentation by Scale

Misrepresentation by Orientation

Links to Map Misrepresentation Sites

- Maps as an Instrument of Propaganda
- Projections and propaganda
- Cartographic Anomalies: How Map Projections Have Shaped Our Perceptions of the World
- Why the Middle East's borders will never be the same again
- We Have Been Misled By An Erroneous Map Of The World For 500 Years
- Map of Twentieth-Century Europe Imagined in 1863

The Power of Maps

Maps are an extremely powerful form of graphic representation. Maps define territory – they tell of ownership and dominion. They can also subvert and propagate alternative world-views. All maps serve an interest and work through two main forms of power.

First, the external power of their creators, often governments or their agents, who control the content of maps both in terms of what is included and what is withheld, and thereby broadcast a particular viewpoint. Second, the internal power of maps themselves – the perception of maps as precise, objective and accurate representations of reality which convey an image of geographical order.

Maps are still regarded by many people as dispassionate representations of the external world. However, this has been challenged in recent decades as their political and cultural connotations are revealed and become more widely understood.

The authoritative appearance of modern maps belies their inherent biases. To use maps intelligently, the viewer must understand their subjective limitations.


THE END